# HANFORD IFRC QUARTERLY REPORT ~ JANUARY 2009

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## I. Overview and Highlights

This is the fourth Quarterly Report for the Hanford IFRC project that summarizes significant progress for the period of October 2008 to January 2009. Six major highlights deserve mention for this reporting period that will be discussed in sections that follow.

1. Pump testing and another round of electromagnetic borehole flowmeter (EBF) measurements were completed in October and early November that, when integrated with the injection experiment described below, complete our hydrologic characterization campaign.
2. A large scale, non-reactive tracer experiment was successfully performed over November –December 2008. The experiment involved the injection of 160,000 gallons of fluid and over 1000 laboratory analyses of $Br^-$ to correlate with downhole ion-selective electrode readings.
3. Significant progress has been made on laboratory geophysical, hydrologic, chemical, and microbiologic characterization of retrieved sediments from the boreholes.
4. The modeling team is working on a publication on the distribution of hydraulic conductivity in the IFRC well-field based on EBF and pump-testing results.
5. The modeling team is integrating the hydrologic characterization results into an improved hydrologic model of the IFRC site that is being used to model results from the first tracer experiment, and to plan for spring passive and active experimental campaigns.
6. The spring passive experiment that will monitor hydrologic and geochemical changes that occur as high river stage waters infiltrate the IFRC well-field is under active planning and design.
7. A series of collaborative experiments has been planned and initiated with PNNL's Subsurface Focus Area (SFA). These involve reactive transport experiments with intact IFRC cores, and down-hole placement of microcosms and coupons of different type in IFRC wells at different depths.

## II. Significant Changes

There have been no significant changes to the project scope or objectives since the last quarterly report in October 2008.

## III. Management & Operations

Management and operations of the Hanford IFRC have proceeded without major problems over this reporting quarter. Site completion, characterization, lab/field experimentation, and project spending has proceeded as planned, and the project overall is on schedule with milestones.  Some issues have arisen over the reporting period on data availability and sharing, geophysical model development, and collaborations with EM. These topics, along with a status report on the November 2008 tracer experiment, the experimental plan, and developing collaborations with the PNNL SFA will be discussed with ERSD management during a visit to Germantown in February, 2009.  The internal IFRC data sharing and collaboration policy is attached as an Appendix.  All IFRC team members participated in the drafting of this policy, and they are expected to follow it.

## IV.  Quarterly Highlights

Task 1.  Project Management

IFRC project management is proceeding as smoothly as can be expected, and there are no outstanding issues with finances, staffing, subcontracts, project productivity, site infrastructure or access, or schedule. To great extent the project is moving forward according to the PI's expectations, but feedback from ERSD and the FREC is solicited. The status of project planning documents noted in the last progress report is as follows:

- Saturated zone experimental plan (Zachara) – This plan will be completed after receipt of analyses for total and adsorbed U in borehole sediments.  These analyses are underway and final results are expected by the end of January.
- IFRC modeling team plan (Rockhold) – A draft has been completed and is in internal PNNL review.
- Vadose zone infiltration gallery development plan (Freshley) – On hold pending further discussions with the newly funded EM polyphosphate infiltration project. See task 5.

Task 2.  Site Design and Installation

A draft of the Borehole Drilling, Sampling, and Well Construction Report has been completed and is in internal review.  It will be posted to the Hanford IFRC web-site by Feb. 1.  An example of some of the information contained in the report is shown by the cross section in Figure 1.  The deep well on the right (2-5, borehole C5708) that penetrates both the Hanford and Ringold formations was placed by the EM-40 environmental surveillance project in 2005, and was used as an exploratory well for the IFRC. This well has been given to the project and is now part of the IFRC well array. The deep microbiology characterization borehole (2-25) sampled this same depth sequence. Note the irregular water table (blue solid line), that changed in response to river stage during the course of well installation.
During November IFRC staff completed the wiring, hook-up, and testing of all thermistors and ERT electrodes in the well field.  This was a significant task as there are over 1500 of these.  We also reconfigured some of the river monitoring stations (stage and temperature) to be more responsive and useful to our needs.  The first tracer experiment showed that continuous river data is needed during the course of a field injection experiment for rigorous interpretation; and like information is necessary for the

planned passive experiment in the spring. The site is now fully operational pending the arrival of more clement weather. Significant additional modifications are not expected to the field site during the remainder of FY 09.

The site was fully winterized in early December after completion of the fall tracer experiment and instrument hook-up. These activities were fortunately completed before the onset on one of the coldest Decembers on record where sustained temperatures of -10$^{o}$ C occurred for three weeks. Additional fieldwork will commence when temperatures moderate.

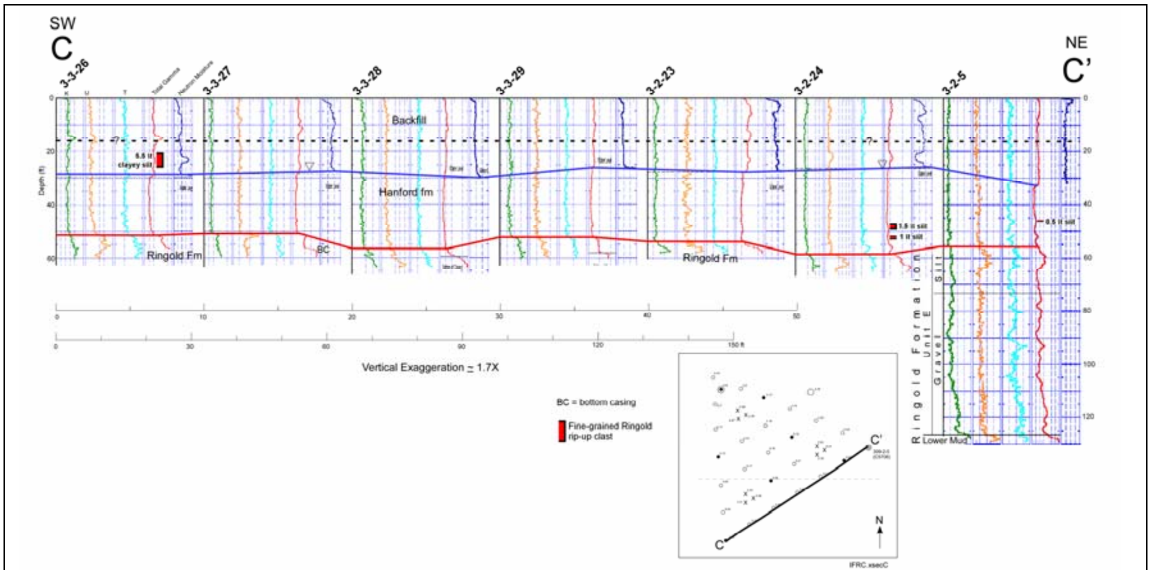


**Figure 1**. IFRC well-field cross section C-C'. Horizontal blue is water table and horizontal red is the Hanford-Ringold contact. Vertical blue is the neutron moisture log; vertical red is total gamma; and K, U, and T are spectral gamma results for potassium, uranium, and thorium.

<u>Task 3. Website and Data Management</u>

There were no new or significant modifications to the IFRC data base. However, the posting of completed data sets has been given priority. New downhole logging data for all wells [borehole deviation (azimuth and tilt), magnetic susceptibility, total magnetic field, total gamma, and electrical conductivity on all the wells] has recently been received from Golder and is posted in the data base. Figure 2 shows an example of down-hole electrical conductivity measurements that has been plotted from the data base.

Data sets that are in intermediate stages of completion (e.g., particle size analysis, chemical measurements of different type), or that have not been completed fully for data-base posting (e.g., QA/QC information or required record trails) are now being posted on an internal IFRC Sharepoint Site that is within the PNNL cyber security firewall. This site cannot be accessed by external participants, but an inventory of files that exists on the site will soon be posted as an informal data file in the data base so that external participants may request the data from PNNL.

<u>Task 4. Field Site Characterization</u>

The IFRC well field is being characterized according to the Hydrologic and Geochemical Characterization Plan that is posted on the web. Significant new progress is described below.

*Geophysical Characterization*

Note previous extensive report on field geophysical characterization progress in the last progress report (October 2008). Field geophysical characterization was suspended during the November tracer experiment and by the onset of very cold weather in early December. The cross-hole ERT measurements, a critical task in field characterization, are awaiting the receipt of a new detector/data logging system that was purchased with BER/ERSD capital and scheduled for delivery at the end of January. A team from the USGS is scheduled to perform downhole density and porosity logging on all IFRC wells during February and March 2009.

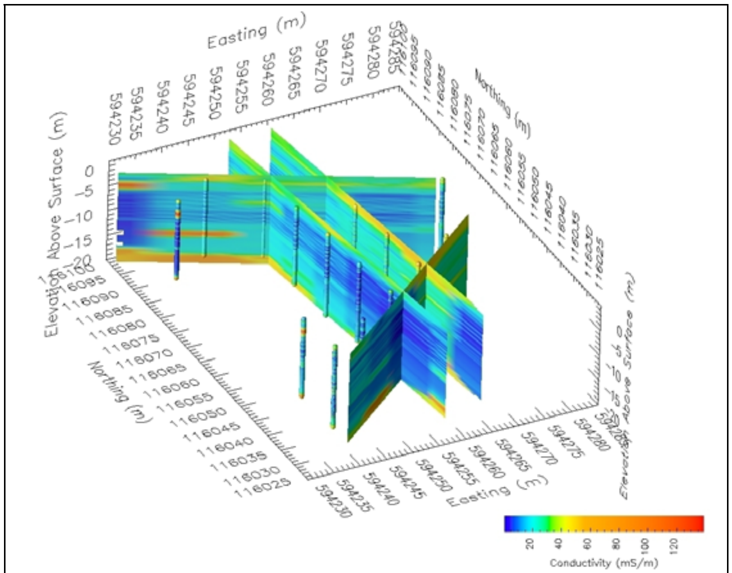


**Figure 2**. Fence diagram for downhole electrical conductivity measurements made by Golder in October 2008.

INL has begun laboratory measurements of sediment electrical properties for the development of correlation relationships between electrical conductivity and sediment physical properties such as fines content (silt and clay) and surface area.

*Geochemical Characterization*

Analyses of total uranium, adsorbed U (bicarbonate extractable U), adsorption affinity ($K_d$) in IFRC synthetic groundwater, surface area, and particle size distribution are nearing completion on the first 100 grab samples selected for characterization. These analyses will be completed by the end of February, but are running about a month or more behind schedule because of difficulties in sieving ("sticky silt" has been problematic in the otherwise very coarse-textured sediments) and QA issues associated with some of the procedures. These complicating issues have been resolved and the analyses are progressing rapidly. Extractable iron forms are soon to be started. Correlation and geostatistical analyses of these new results will begin soon.

Some example results from the USGS for borehole samples from the three-well clusters are shown in Figure 3a, b (Note well designations shown in Figure 4). Figure 3a shows the concentration of adsorbed U (in mol/g) extracted at pH~9.1 with sodium bicarbonate buffer as a function of extraction time. U is generally released from the sediments slowly, with some sediments reaching steady state after 1000 h of extraction. Similar kinetic behavior attributed to intra-grain mass transfer has been observed in previous ERSD research with samples from the SPP (e.g., 1-18, 2-16, and 2-18), that formed the basis for our original proposal submission. The total concentrations of adsorbed U in the new IFRC samples (defined operationally by 1000 h extraction, and ranging between $3.4x10^{-9} – 1.5 x10^{-8}$ mol/g) are equivalent to those measured on previously excavated samples (SPP 1 and SPP 2). Samples SPP 1-18, 2-16, and 2-18 all release U in concentrations greater than the regulatory limit in laboratory column experiments that simulate in-situ conditions. These important findings suggest that published kinetic release models developed for the previously collected excavation samples (e.g., SPP) are likely to hold for the IFRC samples as well. The previously studied SPP-2 excavation site lies within the IFRC experimental domain between wells 3-24 and 3-26.

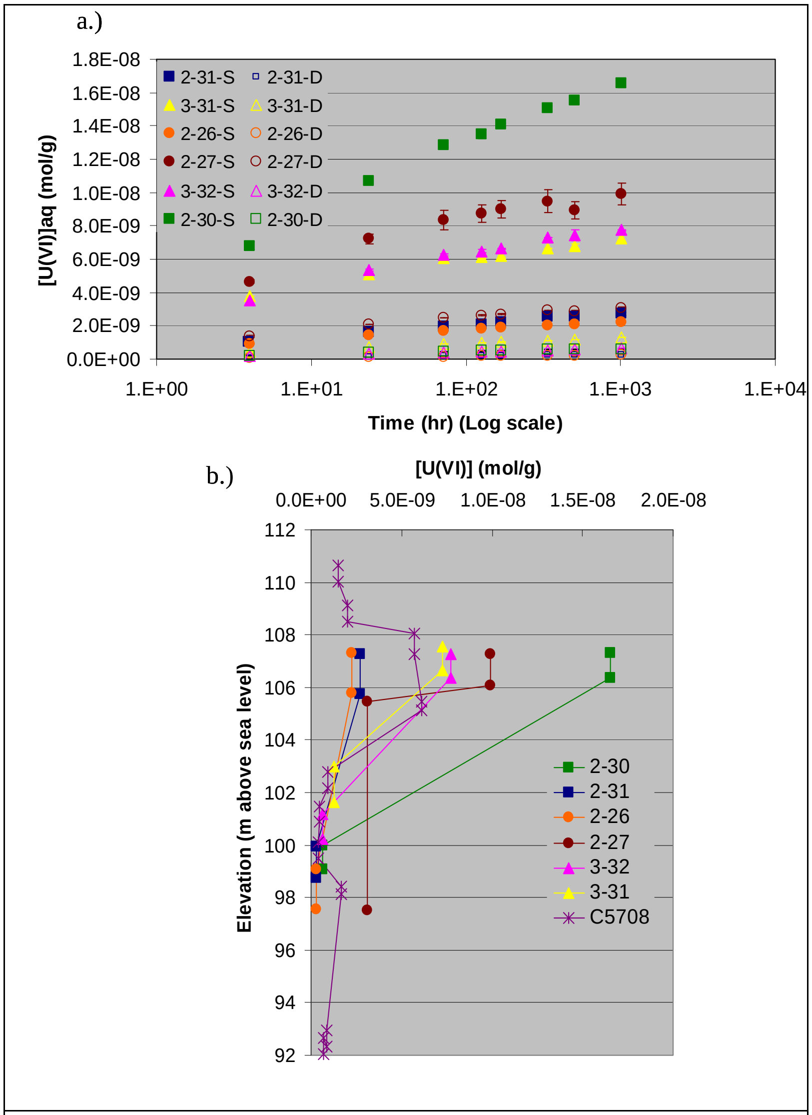


**Figure 3**. a.) Time dependent release of adsorbed contaminant U in bicarbonate buffer from composite shallow and deep saturated zone grab samples from the three well clusters. b.) total extracted adsorbed U after 1000 h contact in bicarbonate buffer. C5708 is also well #2-5 installed by the 300-FF-5 remediation project.

Shallow samples (S) collected from immediately below the water table release more U than do ones from the lower third (D) of the water-saturated Hanford formation (Figure 3b). Moreover, the new IFRC samples (from wells 2-26, 2-27, 2-20, 2-31, 3-31, and 3-32) yield comparable adsorbed U concentrations to those found in earlier collected borehole C5708 (IFRC well 2-5) that lies at the SE corner of the well-field. [Note that samples from C5708 were used in methods development for IFRC characterization procedures during early FY08 before new IFRC samples were available.] These new observations provide further support for the hypotheses that: i.) the smear zone (identified by blue boundaries in Figure 3b) functions as a long-term source of contaminant U to the saturated zone, and ii.) that saturated zone sediments exhibit generally low concentrations of adsorbed U because of high groundwater fluxes. The limited measurements of smear-zone adsorbed concentrations in Figure 3b range by over a factor of ten, indicating that the spatial variability of this source term may be significant. U concentrations (total and adsorbed) will be measured in all smear zone samples from the IFRC well field providing a comprehensive inventory for our experimental domain.

All 37 wells were again sampled for groundwater compositional analysis on Dec. 31, 2008 as part of the lead-up to the spring passive experiment described in Task 6 (Saturated Zone Experimental Program). Multi-level, diffusion cell samplers will be deployed in four wells during February to ascertain whether significant vertical variation in groundwater composition exists.

*Hydrologic Characterization*

In our last quarterly report we described the completion of a first series of electromagnetic borehole flowmeter (EBF) surveys of all the wells. During this reporting period we completed our first round of hydrologic testing and characterization that included repeat EBF measurements in select wells at different river stage to assess vertical in-well gradients, and a series of constant rate injection experiments in eight wells that showed different EBF profiles. The last

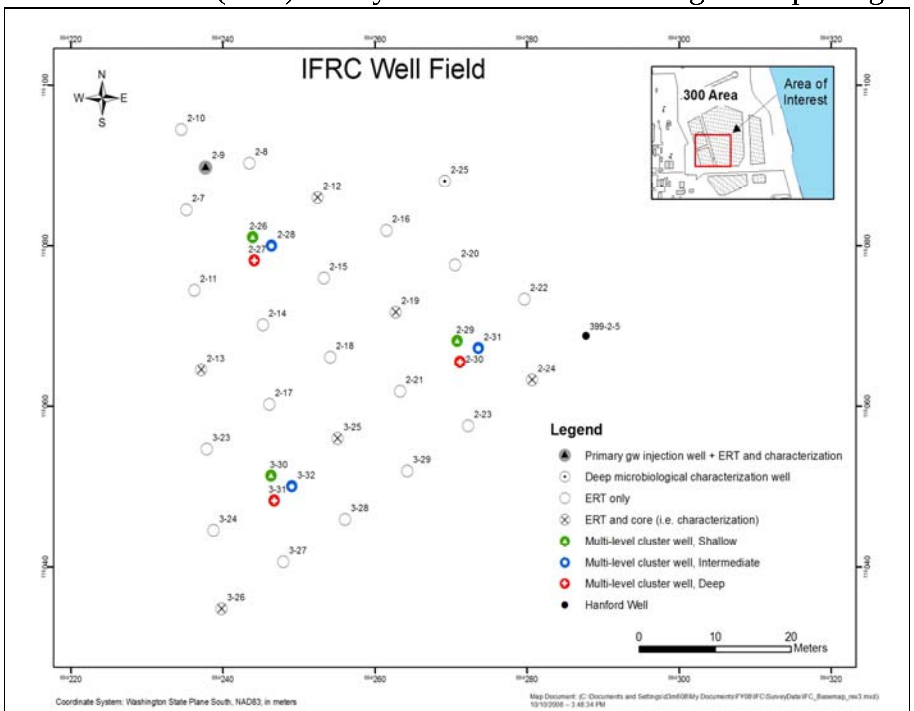


**Figure 4**. IFRC well field layout.

hydrologic characterization activity was a “low-river stage” non-reactive tracer experiment that is described in the paragraphs that follow.

The objectives of the initial IFRC non-reactive tracer experiment were to: i.) rigorously test our field experimental infrastructure and operational procedures for large-scale injection experiments in the saturated zone, ii.) assess transport processes, rates, and formational heterogeneities present in the saturated zone, and iii.) to further refine the site hydrologic model and associated numerical models for more rigorous and informed injection experiments. This initial tracer experiment in the saturated zone was the first characterization activity that provided information on the effective porosity of the aquifer and arrival times at the monitoring wells. Results from this experiment will be used to determine the injection volume and sampling frequency requirements for subsequent field-scale reactive tracer and uranium mass transfer experiments that are planned for the near future in FY 09.

For this initial test, a solution containing a conservative tracer (~56 mg/L $Br^-$) was injected into a single injection well (399-2-9, see Figure 4) and tracer arrival was monitored in surrounding wells. The test was run for a sufficient duration to fully describe the arrival response at the three closest monitoring wells, at which time the injection was stopped and the tracer plume was allowed to drift under natural gradient conditions (note that gradients are significantly impacted by river stage variability). The location of the injected tracer plume within the well field was tracked by sampling selected monitoring wells over time and monitoring with downhole probes. Bromide concentrations were measured in the field using Ion Selective Electrodes (ISE), both in a bench-top flow-through cell for analyzing aqueous samples and in situ using downhole ISE probes. Archive samples were also collected and submitted to PNNL laboratories for verification of $Br^-$ concentration by ion chromatography. Over 1000 laboratory analyses of $Br^-$ have been completed from the experiment.

During the experiment, ~160,000 gal of tracer solution was injected at a rate of 180 gpm into well 2-9, for a total injection phase duration of ~900 minutes (15 hrs). Tracer arrival observed in the three closest monitoring wells is shown in Figure 5. As indicated, the tracer arrival response was comparable in the three available monitoring directions, with a somewhat delayed arrival in the monitoring well located to the east (399-2-8). Evaluation of the full arrival response indicates that the injection could have been stopped after approximately 650 minutes. However, due to inflections observed in the tracer response during earlier times, the test was continued to make sure the arrival response was fully developed. The extended test duration resulted in more than 50% tracer arrival in more distal wells (399-2-11, 2-12, and 2-27), indicating that the radial extent of the emplaced tracer target was larger than originally planned. Another feature of the arrival curves worth noting is the relatively dispersed arrival fronts, indicating that a range of fast and slower pathways are impacting the transport processes.

Tracer concentrations were monitored for several weeks following the injection. Figure 6 shows snapshots of the tracer plume at different elapsed times. Fluctuations in river stage were unexpectedly dramatic, ranging from ~104.2 to ~106 m elevation during the first two weeks of monitoring. The average river stage increased during the first 3.5 days of the experiment which resulted in more westward drift of the tracer plume than was anticipated for this time of year when the river stage is usually low and constant. These results suggest that closer coordination of future aquifer injection experiments with Columbia River Dam operations – namely forecast outflow rates from the upstream Priest Rapids Dam – may be needed. Nevertheless, some interesting features were observed during the experiment, such as regions of the monitored domain in which the tracer was apparently slow to enter, and then slow to leave, which is a consequence of physical heterogeneities and multi-rate mass transfer processes. Average transport velocities were significantly slower in the IFRC experimental domain, than previously observed at the polyphosphate injection site.

A manuscript is now in preparation that integrates results from the downhole EBF surveys, hydrologic pump testing, and the November non-reactive tracer experiment. Moreover, a comprehensive compilation of all chemical and hydrologic measurements made during the tracer experiment is nearing completion that will soon be distributed to the modeling team.

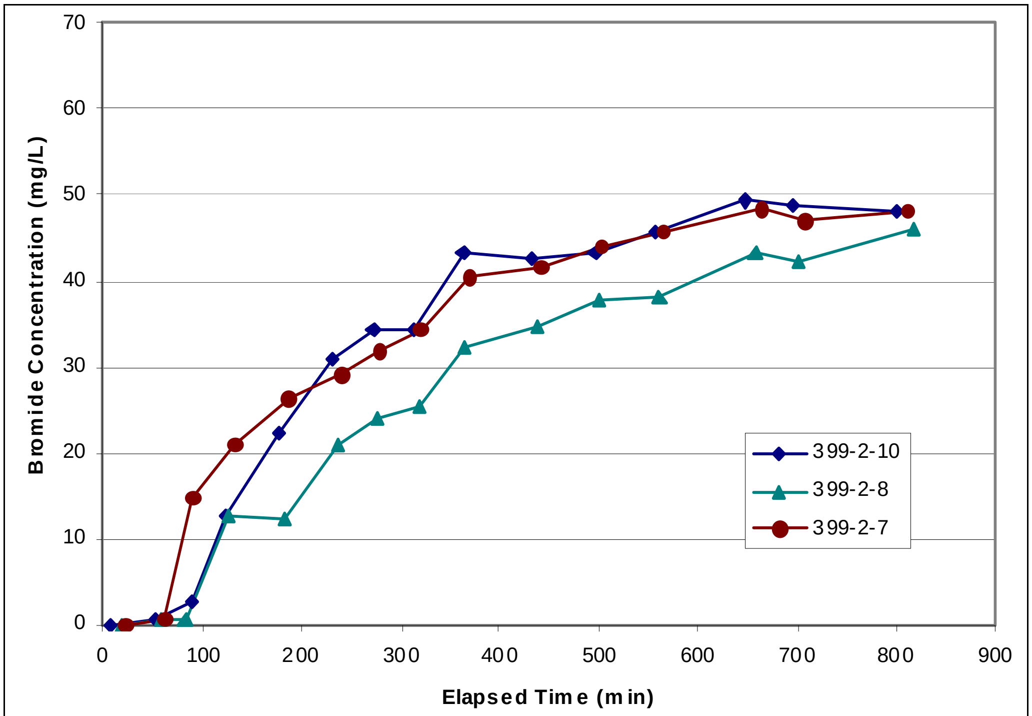


**Figure 5**. Tracer arrival response at the three closest monitoring wells.

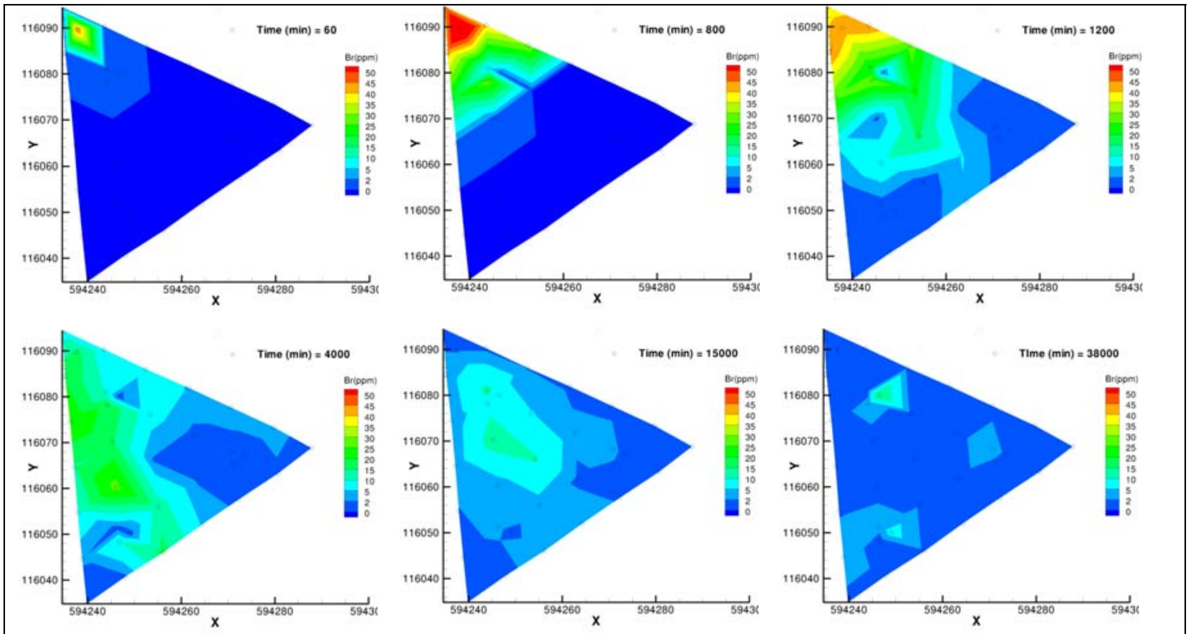


**Figure 6**. Snapshots of bromide plume at selected elapsed times during the initial tracer test at the Hanford 300 Area IFRC site. Tracer injection period was from zero to 900 min.

<u>Task 5.  Vadose Zone Experimental Program</u>

There has been no significant change to this task since the last report.  However, new characterization data is now being generated that quantifies contaminant U concentrations in the vadose zone and capillary fringe that will enable more accurate planning of the vadose zone experimental site and associated research opportunities.  Our current plans do not call for development of the vadose zone site until FY10.  However passive experiments planned for the saturated zone experimental program in FY 09 that are described below in Task 6 will provide the first direct measures of U release from the smear zone and it's mixing with groundwater.

EM-40 has supported a new polyphosphate infiltration treatability study near the 300 A North Process Pond to evaluate the effectiveness of surface applied polyphosphate to reduce U fluxes to groundwater from the lower vadose zone during periods of high water table.  This two year project will develop a vadose zone infiltration site and characterize sediments from it in FY09.  They will subsequently perform a polyphosphate infiltration experiment in March-April of FY10, to evaluate its effectiveness in reducing U mobilization from the smear zone.  Our project team has just become aware of this new EM activity, and we will be developing a collaboration strategy over the next few months.  It is probable that the results of this new EM study will influence the nature of vadose zone experimentation performed at the IFRC site.

Task 6. Saturated Zone Experimental Program

The saturated zone experimental program will get into full swing after the weather moderates, and results from the November 2008 hydrologic characterization tracer experiment have been processed, modeled, and findings incorporated into a updated hydrologic model of the IFRC experimental domain. The site infrastructure performed flawlessly during the experiment, so we are now ready for more complicated and demanding field experiments. Some results of the first tracer experiment were unexpected (e.g., strong coupling with river stage at relatively low river flow), and consequently, its behavior was not accurately forecast with the current site hydrologic model. Thus, modeling the results of the first tracer experiment and updating the site hydrologic model are a priority as we begin to plan our next round of experiments.

Three other saturated zone experiments will be performed during FY 09 whose details are contingent on the modeling described above.

- A late winter, two phase drift experiment (February-April) is planned where: i.) chilled IFRC site groundwater or river water (e.g., ~ $10^{o}$ C) is injected into ambient groundwater (e.g., ~ $17^{o}$ C), and its heterogeneous transport and dispersion monitored using our extensive down-hole thermistor array, followed by ii.) groundwater injection spiked with multiple nonreactive tracers of different diffusivity with plume monitoring by cross-hole ERT, downhole ISE, and laboratory analyses. Robust premodeling will be performed to design the phase 2 experiment so that maximum tracer mass balance is achieved as the plume migrates through the well-field. This may require use of a different injection well with different injection volumes.

- A passive, natural gradient experiment (during April to July) will comprehensively monitor groundwater head, temperature, ionic conductivity, and compositional (e.g., U, $HCO_3^-$, etc.) changes that occur as Columbia River waters rise in response to snowmelt, inundate the lower vadose zone, and later fall as snowmelt ceases. The experiment will rely on a combination of continuous monitoring of select parameters at the river shoreline, intermediate wells, and IFRC wells; as well as strategic sampling of IFRC well waters for laboratory analyses during critical periods of both change and stability. A specialized sampling system will be deployed to monitor U fluxes from the smear zone, to correlate these with measured smear zone sediment U concentrations across the site, and to monitor the impacts of these fluxes on groundwater U concentration and export from the experimental domain. A test plan for this experiment is currently under development

- A warm month, low river stage (July-September) reactive transport experiment where upgradient groundwaters of low U(VI) concentration are injected in the IFRC site and the plume monitored during transport to assess in-situ desorption and mass transfer kinetics, and their linkage to previously characterized flowpath and lithologic heterogeneities. The final design for this experiment is strongly dependent on results from ongoing geochemical characterization measurements (e.g., U concentrations and forms, and spatial variation in $K_d$), and the intact column experiments described in Task 7.

Task 7. Modeling and Interpretational Program

A draft of the Hanford IFRC modeling plan has been completed and is in internal PNNL review.

The progress of the modeling team has increased dramatically over this reporting period, and will continue to do so as new characterization and field experimental results become available. The following are important activities that are underway:

- Zheng (UA) and Rockhold (PNNL) have developed an updated hydrologic model of the IFRC well-field using both MODFLOW and STOMP. The model includes all new hydrologic data collected during FY08 on existing wells proximate to the IFRC experimental domain, and hourly Columbia River stage variations. The model is now being updated to include all new results from hydrologic and geophysical characterization of the IFRC well-field. Zheng had primary responsibility for pre-modeling the November 2008 non-reactive transport experiment, which he completed with skill and in robust manner. Zheng and Rockhold are now collaborating to model the EBF and pump test results, and will move on to the tracer experiment results as soon as they are finalized and compiled, and pass QA/QC evaluation. The site model will be further refined in modeling the tracer experiment.

  The updated hydrologic model will be used to premodel the various experiments planned for late winter, spring, and summer to refine their design parameters. Greater attention will be given to sensitivity calculations that span a larger range of Columbia River stage values then previously thought to be important, and to experiments that utilize different well locations as injection sites.

  Chongxuan Liu from PNNL visited Dr. Zheng at the University of Alabama for discussions on the inclusion of various descriptions of mass transfer at different scales into the MODFLOW code.

- Rubin and his team (UCB) is assimilating field geophysical logging results of all type (from both Stoller and Golder), particle size distribution measurements from borehole samples (100 have been completed to date), and depth discrete hydraulic conductivity values from EBF measurements of all wells and pump testing (modeled by Rockhold and Zheng) within their MAD code (note submitted publication on the approach) to drive inverse calibration of a hydraulic conductivity flow field for the IFRC experimental domain. The inverse modeling is being performed in collaboration with Peter Lichtner (LANL) and Glenn Hammond (PNNL) who are using parallelized computational routines developed by SCiDAC for the processing of large data sets. A parallelized version of Lichtner's reactive transport code, P-FLOTRAN, is being used as the forward

- hydrologic model for these analyses.
- Reactive transport experimentation with intact IFRC sediment cores (Figure 7) has been initiated in the EMSL Subsurface Flow and Transport Facility (SFTF) in collaboration with the PNNL SFA to begin parameterization of U(VI) multi-component reaction networks (thermodynamic, kinetic, and mass-transfer) on saturated zone IFRC sediments. The experiments will be performed with flow rates, U(VI) concentrations, and simulated groundwater compositions that closely mimic those observed at the site. Three representative core sections, containing approximately 60% gravel, have been selected for study from the top, middle, and lower thirds of the saturated Hanford formation. This experiment series has been carefully planned over the last three months by an integrated team including both experimentalists and modelers. Four different phases of reactive transport experimentation (desorption of contaminant U, adsorption/desorption of spiked U) and hydrologic characterization will be performed after which the cores will be dissected for rigorous physical and geochemical characterization. Reactive transport analyses and reaction network parameterization will be performed using both the STOMP (Rockhold) and FLOTRAN (Lichtner) codes. These results will be used for a publication on robust reaction parameter scale-up, but will also provide empirical retardation data useful in premodeling our first field transport experiment in August 2009.

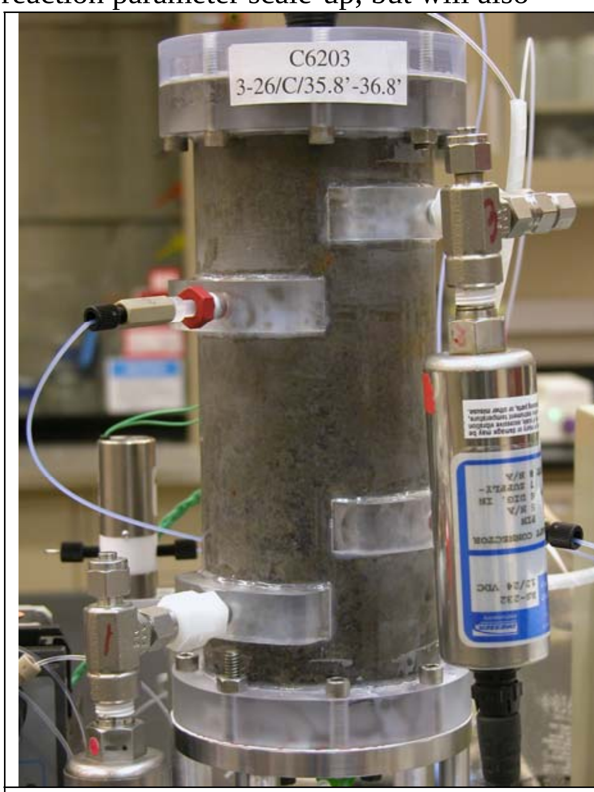


**Figure 7**. Experimental setup for reactive transport experiments with intact IFRC cores. There are multiple access ports and a transducer for internal pressure/suction measurements.

Task 8. ERSD Outreach

Site tours and discussions were given to student-professor groups from Washington State University and Montana State University, and to Dr. Anna Palmisano of BER.

The site hosted a TV interview crew from PBS in Seattle who were preparing a documentary film on groundwater at Hanford. We were told the clip would air after January 1, 2009, but we have not been heard a final date.

The IFRC completed sampling of a unique, continuous 50 m core through the entire unconfined aquifer to the top of basalt (well #2-25). The borehole was located 10 m east of the IFRC well field, and was completed as a well in the more anoxic Ringold Formation for future in-situ biogeochemistry research. This core was primarily collected for microbiological characterization, and high-quality, intact subsurface cores were provided to PNNL's ERSD Scientific Focus Area (SFA) researchers (Konopka and Fredrickson) and their external collaborators (Knight at the University of Colorado, Roden at the University of Wisconsin, and Loeffler at Georgia Tech). Core samples were also sent to ERSD investigator Joel Kostka at the University of Florida for investigations of microbial heterogeneity.

Seventeen samples from the borehole were selected for intensive microbiological investigation at PNNL, with emphasis on replicated samples from distinct geological facies, and physical/chemical transition zones (such as the Hanford-Ringold contact and a redox interface in the Ringold formation). The exterior of core samples were pared away and the intact interiors were subsampled and processed for microbial analyses. The analyses included: i.) biomass measures, ii.) extraction of DNA for molecular analyses (both phylogenetic and functional gene information), iii.) three discrete strategies for isolation of cultures with selection for growth on one of six specific terminal electron acceptors, and iv.) analyses of functional potential in sediments. Direct microscopic counts have shown that the transmissive Hanford formation contains approximately 1-5 x $10^8$ cells per g sediment, and cell numbers decline to the range of 2-5 x $10^7$ in the Ringold formation (Figure 8). In materials collected near the contact with the basalt at the base of the unconfined aquifer, cell numbers of 1 x $10^7$ per g were found. The highest proportion of metabolically active cells (using the fluorescent probe Redox Sensor Green) were found in the Hanford saturated zone and across the Hanford-Ringold contact (Figure 8). Enrichment cultures from the Hanford saturated zone have exhibited positive reactions within 2 weeks when ferrihydrite or manganese oxides were provided as terminal electron acceptors. Transfers from the ferrihydrite enrichments have shown growth within 6 days. PCR-amplifiable DNA has already been isolated from some of the samples. Some of this material will be sent to the Joint Genome Institute, for sequencing of 16S rRNA amplicons, as part of a Community Sequencing Program project. Discussions are underway with the PNNL SFA team to emplace microcosms of different type in several of the wells at different depths to investigate in-situ biochemical processes.

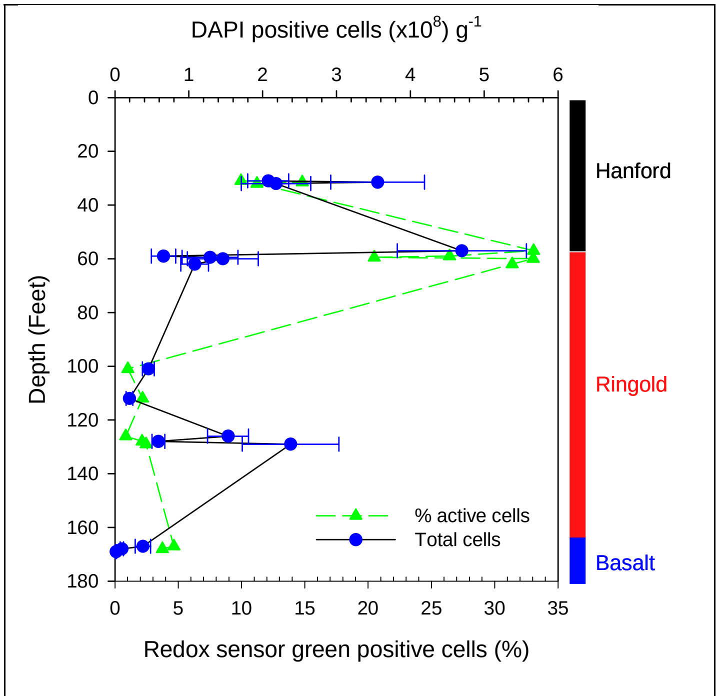


**Figure 8**. Depth distribution of total and metabolically-active cells in the deep microbiological characterization well (2-25).

A full inventory of IFRC sediments collected during the drilling campaign, including those from the deep microbiology borehole described above, has been posted on the web, and many of these are available to ERSD investigators should they ask.

## V. Non-IFRC Project Activities

There have been no changes in this activity since the last reporting period.

## VI. Funding Issues

Project spending was on track with projection for the first quarter of FY 09 and there were no funding issues. At time of report writing 23.1% of FY 09 time has elapsed and 27% of funds have been spent.

## VII. Upcoming Plans/Issues

The following items summarize plans for the second quarter of FY 09 (January-April)

- Deploy passive multi-level sampling system in four wells with different EBF profiles to characterize vertical profiles in groundwater composition.
- Integrate EBF measurements with constant rate injection test results to yield vertical profiles in hydraulic conductivity for each well. Transmit results to UCB
- Complete multi-organization modeling of first tracer experiment for publication utilizing as much new hydrologic characterization data as is possible.
- Utilize improved hydrologic model for premodeling of “high-water” temperature and non-reactive solute tracer experiments for late spring 09, and finalize injection experiment 2 plans incorporating “lessons learned” from injection experiment 1.
- Document functioning of continuous river-well monitoring systems (temp., water level, and electrical conductivity) in preparation for spring “high water” passive experiment of river water intrusion into the aquifer and U mobilization from the capillary fringe.
- Perform cross-hole ERT measurements in all wells for facies characterization using new detector, initiate laboratory measurements of electrical properties at INL, and settle on modeling approach for geophysical data inversion.
- Complete initial suite of geochemical and physical characterization measurements by March-end and begin geostatistical analyses.
- Prepare for ERSD contractors meeting, including demonstration of the MAD/FLOTRAN data inversion approach for geostatistical analysis of the spatial distribution of hydraulic conductivity for the IFRC well-field.

## VIII. Peer Reviewed Publications, Abstracts, and Presentations

<u>Presentations:</u>

Hammond, G. and P. Lichtner. 2008. Massively Parallel Ultrascale Subsurface Simulation. *Computational Methods in Water Resources XVII,* July 6-10, 2008. (partial IFRC support).

Hammond, G. E., P. C. Lichtner, R. T. Mills, and C. Liu. 2008. Toward Petascale Computing in Geosciences: Application to the Hanford 300 A – art. No.012051. *Journal of Physics Conference Series*. Vol. 125, p.12051-12051.

Ma, R., C. Zheng, H. Prommer, J. M. Zachara, C. Liu, and M. Rockhold. 2008. Modeling uranium fate and transport at the Hanford Integrated Field Challenge Site, presented at the "MODFLOW and More 2008" International Conference, Golden, CO.

Ma, R., C. Zheng, H. Prommer, and J. Greskowiak. 2008. A Preliminary Assessment of the Effects of River Water Dynamics and Chemistry on Uranium Fate and Transport at the Hanford 300A Site, *Eos Trans. AGU, 89*(52), Fall Meet. Suppl., Abstract H31B-0850.

Yin, J., R. Haggerty and J. D. Istok. 2008. Experimental Investigation of the Effect of Transient Groundwater Flow on Dispersion, *Eos Trans. AGU*, *89*(52), Fall Meet. Suppl., Abstract H41C-0888.

Zachara, J. M., J. Davis, J. M. McKinley, D. Singer, J. Stubbs, G. E. Brown, Z. Wang, and J. –F. Boily. 2008. Frontiers in Environment Remediation Research, presented at the *Synchrotron Environmental Science IV Conference,* San Francisco, CA, December 12, 2008.

Zachara, J. M., M. Rockhold, J. Fredrickson, V. Vermeul, A. Ward, C. Liu, J. M. McKinley, B. Bjornstad, M. Freshley, R. Haggerty, D. Kent, P. Lichtner, Y. Rubin, R. Versteeg, and C. Zheng. 2008. Hanford's 300 Area Integrated Field Research Challenge Site, *Eos Trans. AGU 89*(53), Fall Meet. Suppl. Abstract H33G-1102.

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Stoliker, D., J. A. Davis, and J. M. Zachara. 2008. Characterization of metal contaminated sediments: Distinguishing between samples with sorbed and precipitated metal ions. *Environmental Science and Technology* (submitted).

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<u>In review over the reporting period:</u>

Um, W., J. M. Zachara, C. Liu, and D. Moore. 2008. Resupply mechanism to a contaminated aquifer: A laboratory study of U(VI) desorption from capillary fringe sediments. *Geochimica et Cosmochimica Acta* (Submitted).

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## IX. Appendix - Hanford IFRC Data Sharing Policy

(Rev. 1; December 23, 2008)

The success of the Hanford IFRC project requires open sharing of pre-publication data and modeling results among the project team. To facilitate and enable scientific advance and publication, each investigator must be willing to proactively share mature, unpublished data through the IFRC data base or via response to direct request from other project investigators. In turn, investigators must be assured that their data ownership rights are protected.

**Definitions.**

*Data* is defined broadly as all measurement, modeling and intellectual products associated with the IFRC and the Hanford 300 area including: geologic description, analytical measurement, and/or laboratory or field experimentation; innovative field infrastructure and monitoring designs and systems; or modeling or numerical analyses, information assimilation, and/or reanalysis.

- *Mature data* are those data which have undergone preliminary quality assurance/quality control.
- The *data owner* is defined as the person who has applied their own expertise, intellectual faculties, and time to develop data or original modeling results.
- A *Hanford IFRC investigator*, hereafter referred to as "*investigator*" is any PI/co-PI, employee or student of a PI/co-PI on the Hanford IFRC project.

**Policies.**

1. All mature data should be posted to the IFRC website within 90 days of collection. In cases where posting of a complete data set is infeasible (e.g., extremely large modeling files associated with a numerical simulation), a compressed version of the data should be posted.
2. Data on the IFRC website will be associated with a data owner.
3. Data owners may choose one of the following three access designations when posting their data.
   A. Permission-required data. Data are available to investigators with permission of the data owner. Most investigator data will likely fall into this category initially. It is expected that investigators will allow broad access to other investigators to most data.
   B. Acknowledgment-required data. Data are available to all investigators. Use of the data in publications and presentations require acknowledgement of the data owner and, where appropriate, citation. It is expected that after initial publication, permission-required data (A) will pass into category B.
   C. Open access data. Data are available to all investigators without restriction. All public domain data automatically fall into this category – e.g., USGS river stage data.

4. Data owners retain the right of first publication of the data in categories A and B. Category A data will transform to category B data one year after posting unless the data owner petitions the IFRC P.I. with a valid reason for why the data has not been brought to timely publication.
5. Most data will enter the public domain (category C) two years after the completion of the IFRC project.
6. Investigators shall communicate intended uses of data to the data owner so that redundant and/or overlapping analysis activities do not occur that data owners will be appropriately considered as authors on ensuing publications or presentations.
7. Recipients of data must not allow a research project that differs substantially from project originally communicated in the data request to be undertaken by themselves or others without first obtaining approval from the data owner. Data must not be transferred to other investigators without approval of the data owner.
8. All investigators are responsible to train and mentor their students and employees in the proper, appropriate, and courteous use of others' data, and to ensure that permission, acknowledgment, and citation are obtained from or given to the data owner.

Data owners should be given timely opportunity to review others' publications based on their data, and be given the opportunity to provide prior feedback when their data are used in presentations.